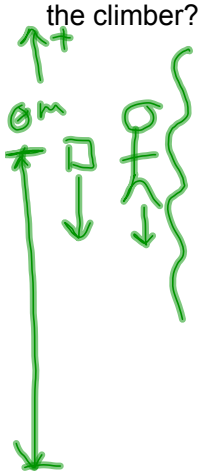
Free-Fall Practice Problems 4th Block 8.31.11

A small first-aid kit is dropped by a rock climber who is descending steadily at 1.3 m/s. After 2.5 s, what is the velocity of the first-aid kit, and how far is the kit below the climber?



$V_i = -1.3\ m/s$

$a_g = -9.8\ m/s^2$

$t = 2.5\ s$

$V_f = ?$

$$V_f = V_i + gt$$
$$= -1.3\ m/s + (-9.8\ m/s^2)(2.5\ s)$$
$$= -25.8\ m/s$$

$$\text{diff. kit/climber} = \Delta y_{kit} - \Delta y_{climber}$$
$$= -33.9\ m - (-3.25\ m)$$
$$= -30.6\ m$$

$$\Delta y_{kit} = V_i t + \frac{1}{2} a_g t^2$$
$$= -33.9\ m$$

$$\Delta y_{climber} = V_i t$$
$$= (-1.3\ s)(2.5\ s)$$
$$= -3.25\ m$$

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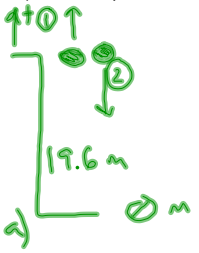
Two students are on a balcony 19.6 m above the street. One student throws a ball vertically downward at 14.7 m/s. At the same instant, the other student throws a ball vertically upward at the same speed.
a) What is the velocity of each ball as it strikes the ground?
b) What is the difference in time the balls spend in the air?
c) How far apart are the balls 0.80 s after they are thrown?



$V_{i1} = +14.7\ m/s \qquad V_{i2} = -14.7\ m/s$

$\Delta y = -19.6\ m \qquad a_g = -9.8\ m/s^2$

a)

1:

$$V_{f1}^2 = V_{i1}^2 + 2a_g\Delta y$$

$$= \pm\sqrt{V_{i1}^2 + 2a_g\Delta y}$$

$$= \pm\sqrt{(+14.7\ m/s)^2 + 2(-9.8\ m/s^2)(-19.6\ m)}$$

$$= -24.5\ m/s$$

$$V_{f2}^2 = V_{i2}^2 + 2a_g\Delta y$$

$$= \pm\sqrt{(-14.7\ m/s)^2 + 2(-9.8\ m/s^2)(-19.8\ m)}$$

$$= -24.5\ m/s$$

b) 1:

$$t = \frac{V_{f1} - V_{i1}}{a_g}$$

$$= \frac{-24.5\ m/s - (+14.7\ m/s)}{(-9.8\ m/s^2)}$$

$$= 4\ s$$

2:

$$t = \frac{V_{f2} - V_{i2}}{a_g} = 1\ s$$

$$\Delta t = t_1 - t_2 = 4\ s - 1\ s = 3\ s$$

c)

$$\Delta y_1 = V_{i1}t + \frac{1}{2}a_g t^2$$

$$= (+14.7\ m/s)(.8\ s) + \frac{1}{2}(-9.8\ m/s^2)(.8\ s)^2$$

$$= 8.62\ m$$

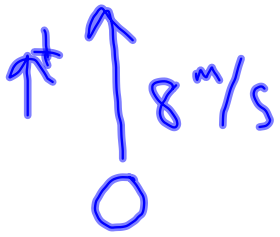
$$\Delta y_2 = V_i t + \frac{1}{2}a_g t^2$$

$$= (-14.7\ m/s)(.8\ s) + \frac{1}{2}(-9.8\ m/s^2)(.8\ s)^2$$

$$= -14.9\ m$$

$$\Delta y_{total} = \Delta y_1 - \Delta y_2 = 8.62\ m - (-14.9\ m) = 23.5\ m$$

A tennis ball is thrown vertically upward with an initial velocity of 8.0 m/s.
a) What will the ball's speed be when it returns to its starting point?
b) How long will the ball take to reach its starting point?



a) $V_f^2 = V_i^2 + 2a_g\Delta y^0$

$V_f = \pm\sqrt{V_i^2}$

$= -V_i$

b) $V_f = 0$ m/s $V_i = +8$ m/s

$$t = \frac{V_f - V_i}{a_g} = \frac{0 \text{ m/s} - 8 \text{ m/s}}{-9.8 \text{ m/s}^2} = .816 \text{ s}$$

full time: double .816 s = 1.63 s